Environmental Biophysics Branch;
Summary Statement

by Colin F. Chignell

At the present time, the research programs of the Environmental Biophysics Branch cover essentially two areas—nonionizing radiation (microwaves) and noise (auditory and nonauditory effects). Two new programs—the biological effects of light and molecular biophysics—will be started in the very near future.

Nonionizing Radiation

It is the aim of scientists working in the microwave program to develop new microwave exposure systems and to determine the effect of microwave exposure on human health. An important aspect of their research is the development of microwave delivery systems which permit exposure of suitable test systems to continuous wave, pulsed wave and modulated wave radiation of known field characteristics. Other efforts are directed towards the development of instrumental and analytical dosimetric techniques as well as the evaluation of the electrical properties of biological materials.

In the health effects area, they are studying the biophysical mechanisms of the interaction of continuous wave, pulsed and modulated 1–10 GHz microwave radiation with biological samples at cellular and molecular levels and are evaluating the effects of continuous wave and pulsed 2.45 GHz microwave radiation on embryonic development and reproductive functions of exposed animals. They are also examining the effects of continuous wave and pulsed 2.45 GHz microwave radiation on the development of the immunological response in animals and investigating the effect of continuous wave pulsed and modulated 1–10 GHz microwave radiation on central nervous system functions and behavior in animals. Studies on the biological effects of 2.45 GHz radiation on a variety of *in vitro* systems (DNA, mouse embryos, rabbit erythrocyte, rat lymphocytes) have failed to reveal any significant changes in the irradiated systems other than those that could be directly attributable to thermal heating. However, a small decrease in fertility has been observed when male quails that had been exposed *in ovo* to microwaves were mated with either control or exposed females.

Other research, undertaken by contract, involves an examination of the effects of microwaves, electrical field and magnetic field exposure on biological rhythms in rats; on conditioned behavior in primates; and on urinary excretion of various metabolites and other indicators of neurohormone secretion. These studies may help answer questions about possible health effects of radiation from high voltage lines. Also being studied by contract are the effects of chronic exposure to low levels of microwaves. This is a particularly important aspect of microwave research, since data on long-term effects are needed for the formulation of microwave radiation safety levels.

Noise

The noise program consists of attempts to develop new techniques to deliver and measure sound and signals within the mammalian auditory chain and studies to determine the effects of chemicals and drugs on basic mechanisms of hearing.

To deliver and measure sound within the auditory chain, a technique has been developed to activate the ossicular chain directly. This device permits researchers to impart precisely controlled complex signals into the chain by direct electrical-mechanical transduction. In studies with the guinea pig cochlea, no statistical differences were found between cochlea response in terms of word discrimination to normal acoustic and to direct ossicular chain coupled speech. Understanding of the intracochlear signal transduction mechanism is currently limited by the inability to measure the basilar membrane's actual displacement. To increase understanding of this mechanism, scientists are trying to develop probes which will record sounds at the inner ear basilar membrane. Recent work suggests that noncontacting fiber optic levers may be useful

for such studies. Also under current development is an impact noise generator. With the aid of this device, it should be possible to carry out well controlled laboratory studies of hearing damage from a type of noise which pervades industry and society.

In the health effects segment of the program, scientists have studied the effect of methyl mercury on nerve action potential of the inner ear and have measured the concentration of methyl mercury, a known ototoxic agent, in the inner ear fluids. They also studied ototoxic antibiotics and noise, separately and in combination, for their effect on the function and metabolism of hair cells in the inner ear. Other studies are in progress on the effects of noise and ototoxic chemicals on ion flux in the perilymphatic space. The basic objectives are to define the sites of action of chemicals in combination with noise and to understand why synergisms of effect may occur.

Light

This new program will be concerned with the interaction of ultra-violet and visible radiation with various chemical agents (drugs, topically applied agents, and environmental pollutants) within the skin and other exposed tissues. Initial work will involve the photochemistry of known photosensitizers and photoallergens which cause skin phototoxicity. Efforts will be made to identify the end products of photodegradation and to detect the formation of reactive chemical species during light irradiation. These studies will be followed by *in vivo* experiments in which the biochemistry and pathology of the skin of experimental animals will be monitored during exposure to light and known phototoxic agents. Finally, the effect of light of different wavelengths on the behavior of experimental animals and their response to drugs and other chemicals will be studied.

Molecular Biophysics

The initial phase of this program will involve the setting up of various physical techniques to study the interaction of chemical and physical agents with biological systems. Particular emphasis will be placed on spectroscopic techniques, e.g., fluorescence spectroscopy, electron spin resonance, circular dichroism, and rapid reaction spectrometry. Fluorescence spectroscopy should be a particularly useful tool, since many environmental agents are highly fluorescent. When the chemical agent is not fluorescent, then the interaction will be followed with the aid of fluorescent probe molecules. Electron spin resonance will be used to detect the formation of highly reactive free radical intermediates during xenobiotic metabolism. In addition, this technique will be employed, in conjunction with stable free-radical probes (spin labels), to monitor the binding of environmental agents to biologically important macromolecules, e.g., proteins, nucleic acids, membranes. Circular dichroism is a powerful tool for examining changes in the conformation of biomolecules as they interact with various ligands. Finally, with the aid of a stopped-flow spectrometer, it will be possible to follow the kinetics of interaction between chemical agents and their biological target sites. This technique can also be used to detect the formation of short-lived intermediate complexes which, in turn, may yield information on the mechanism of a particular ligand–macromolecule interaction.